IN THE SPECIFICATION:

Please substitute the following paragraph for the paragraph starting at page 1, line 10 and ending at line 27. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B1

The need for higher density of a semiconductor device such as an IC or LSI has been increased more and more. In reduction type projection exposure apparatuses (steppers) wherein an image of a circuit pattern of a mask (reticle) is formed on a photosensitive substrate (wafer) through a projection optical system and the photosensitive substrate is exposed in accordance with a step-and-repeat method, or in reduction type projection exposure apparatuses (scanners) wherein a photosensitive substrate is exposed with a circuit pattern of a mask (reticle) in accordance with a step-and-scan method, many improvements have been attempted with respect to the resolution of a projection optical system and the precision of pattern registration for repeated projection exposures, printing different patterns upon the same region, to thereby meet the requirements of higher density integration.

Please substitute the following paragraph for the paragraph starting at page 3, line 2 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B2

Japanese Laid-Open Patent Application, Laid-Open No. 121816/1989, shows an example of fine adjustment of aberration of a projection system, wherein an aberration adjusting optical system comprising a light transmissive parallel flat plate is inserted onto an optical path between an image side of a projection optical system, having telecentricity, and an imaging plane thereof, to thereby adjust spherical aberration and on-axis coma aberration of the

B2 concld

projection optical system. In this structure, the spherical aberration of the projection optical system can be adjusted by changing the thickness of the parallel flat plate, while the on-axis coma aberration can be adjusted by tilting the parallel flat plate.

Please substitute the following paragraph for the paragraph starting at page 3, line 17 and ending at page 4, line 10. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B3

Japanese Laid-Open Patent Application, Laid-Open No. 27743/1998, shows another example of fine adjustment of aberration of a projection system, wherein an aberration adjusting optical system is provided on an optical path between an image side of a projection optical system, having telecentricity, and an imaging plane thereof. The aberration adjusting optical system comprises two parallel flat plates having the same refractive index and the same thickness and being inclined with respect to an optical axis in opposite directions and by the same angle, means for changing the tilt angles of these two transparent flat plates in opposite directions and by the same amount, means for rotating the whole adjusting optical system integrally about the optical axis of the projection optical system, and means for tilting the whole adjusting optical system integrally in a desired direction. This aberration adjusting optical system adjusts spherical aberration, on-axis astigmatism, and on-axis coma aberration individually.

Please substitute the following paragraph for the paragraph starting at page 6 line 9 and ending at line 27. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B4

Japanese Laid-Open Patent Application, Laid-Open No. 183190/1995, shows a projection exposure apparatus having an illumination optical system for illuminating a reticle and a projection optical system for projecting a pattern of the reticle, illuminated with the illumination optical system, onto a wafer at a predetermined reduction magnification. Optical means having a refracting power which is revolutionally asymmetrical with respect to an optical axis of the projection optical system, is disposed between the reticle and the wafer. This optical means is made rotatable about the optical axis of the projection optical system or it is made movable along the optical axis of the projection optical system, so as to correct any optical characteristic remaining in the projection optical system and being revolutionally asymmetrical with respect to the optical axis. However, on-axis coma aberration such as described above can not be corrected with this optical means.

Please substitute the following paragraph for the paragraph starting at page 7, line 2 and ending at line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B5

It is an object of the present invention to provide an optical system by which on-axis coma aberration or an aspect magnification error can be corrected.

Please substitute the following paragraph for the paragraph starting at page 10, line 19 and ending at line 25. A marked-up copy of this paragraph, showing the changes made thereto is attached.

In accordance with an eighth aspect of the present invention, there is provided a projection system, comprising: a projection optical system; and an optical system according to the sixth or seventh aspect of the present invention, for correcting an aberration to be produced in said projection optical system.

B6

Please substitute the following paragraph for the paragraph starting at page 12, line 14 and ending at line 18. A marked-up copy of this paragraph, showing the changes made thereto is attached.

Figure 1 is a schematic view of an aberration adjusting optical system according to a first embodiment of the present invention, and it shows optical paths in a portion of a projection system having such an aberration adjusting optical system.

B7

Please substitute the following paragraph for the paragraph starting at page 13, line 4 and ending at line 14. A marked-up copy of this paragraph, showing the changes made thereto is attached.

In Figure 1, the projection optical system 17 is telecentric on its image plane side, and the orientation of chief rays of imaging lights is parallel to an optical axis 14. A projection optical system of an exposure apparatus, for example, for use in the manufacture of semiconductor devices may preferably comprise such an optical system being telecentric on its

B8

B8 cncld

exit side, to prevent a change in imaging magnification of a device pattern image, depending on the wafer surface position with respect to the optical axis direction.

Please substitute the following paragraph for the paragraph starting at page 17, line 10 and ending at page 18, line 7. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B9

On the other hand, it will be readily understood that, even if the refracting power is sufficiently weak, not only the aspect magnification difference but also other aberrations such as a spherical aberration, which are influential to the imaging characteristic, are produced due to the aberration changing optical system 13. Therefore, it is necessary to design the projection optical system 17 while taking into account the influence of the aberration changing optical system 13. Further, in consideration of the property that the spherical aberration of the projection optical system 17 depends on the thickness of the aberration changing optical system 13, the spherical aberration of the projection optical system 17 as a product may be measured in practice and then a best thickness of the aberration changing optical system 13 may be determined. Further, the on-axis coma aberration of the projection optical system 17 may be measured and, on the basis of the result thereof, a best tilt angle of the aberration changing optical system 13 may be determined. Then, by tilting the aberration changing optical system 13 about an axis orthogonal to the optical axis, the on-axis coma aberration can be adjusted.

Please substitute the following paragraph for the paragraph starting at page 20, line 12 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B10 With use of the aberration changing optical system of this embodiment, in addition to the aspect magnification error, other aberrations such as a spherical aberration, an on-axis coma aberration and an on-axis astigmatism, for example, can be adjusted.

Please substitute the following paragraph for the paragraph starting at page 20, line 17 and ending at page 21, line 3. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B11 More specifically, the aspect magnification error can be adjusted in accordance with the same principle as in the first embodiment. The spherical aberration can be adjusted by changing the central thickness of the two optical elements 311 and 312, by changing one by another. The on-axis astigmatism can be adjusted by rotating the aberration changing optical system 13 as a whole integrally, about the optical axis of the projection optical system, and by changing the tilt angles of the two optical elements 311 and 312 in opposite directions and by the same amount. Further, the on-axis coma aberration can be adjusted by tilting the aberration changing optical system 13 integrally.

Please substitute the following paragraph for the paragraph starting at page 22, line 14 and ending at line 22. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B12 Figure 4 is a schematic view of a main portion of an aberration changing optical system according to a third embodiment of the present invention. In this embodiment, the aberration changing optical system 13 comprises two optical elements 411 and 412 having the same refractive index and the same central thickness and being tilted with respect to the optical axis, in opposite directions and by the same angle.

Please substitute the following paragraph for the paragraph starting at page 23, line 4 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B13 The aberration changing optical system 13 of this embodiment is provided with first rotating means for rotationally moving these two optical elements 411 and 412 about axes perpendicular to their flat faces 411a and 412a, respectively, and first tilting means for changing the tilt angles of the two optical elements in opposite directions but by the same amount. Additionally, there are second rotating means for rotationally moving the whole aberration changing optical system 13 integrally, about the optical axis of the projection optical system, and second tilting means for tilting the whole aberration changing optical system integrally, in a desired direction.

Please substitute the following paragraph for the paragraph starting at page 25, line 23 and ending at page 26, line 12. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B14

The angle defined between the direction in which the cylindrical surface 411b of the first optical element 411 has a curvature and the direction in which the cylindrical surface 412b of the second optical element 412 has a curvature, can be adjusted as desired. Here, the aspect magnification difference to be imparted by the aberration changing optical system varies continuously from zero to a maximum. Thus, within a range from zero to an adjustable largest value, the aspect magnification difference in a desired amount and direction to be produced by the projection optical system can be adjusted through the aberration changing optical system of this embodiment. Further, like the second embodiment, the spherical aberration, the on-axis coma aberration and the on axis astigmatism of the projection optical system can be adjusted independently of each other, as desired.

Please substitute the following paragraph for the paragraph starting at page 28, line 2 and ending at line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B15

Figure 5 is a flow chart of a procedure for the manufacture of microdevices such as semiconductor chips ( e.g., ICs or LSIs), liquid crystal panels, or CCDs, for example.

Please substitute the following paragraph for the paragraph starting at page 28, line 6 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

B16 Step 1 is a design process for designing a circuit of a semiconductor device. Step 2 is a process for making a mask on the basis of the circuit pattern design. Step 3 is a process for preparing a wafer by using a material such as silicon. Step 4 is a wafer process (called a pre-process) wherein, by using the so prepared mask and wafer, circuits are practically formed on the wafer through lithography. Step 5 subsequent to this is an assembling step (called a post-process) wherein the wafer having been processed by step 4 is formed into semiconductor chips. This step includes an assembling (dicing and bonding) process and a packaging (chip sealing) process. Step 6 is an inspection step wherein an operation check, a durability check and so on for the semiconductor devices provided by step 5, are carried out. With these processes, semiconductor devices are completed and they are shipped (step 7).

IN THE CLAIMS:

Please amend claims 1-5 and 11-15 as follows. A marked-up copy of the amended claims showing the changes made thereto, is attached. Note that all the claims currently pending in this application, including those not presently being amended, have been reproduced below for the Examiner's convenience.

B17 Sub C1 1. (Amended) An aberration changing optical system for changing an aberration, said optical system comprising: